

What is claimed is:

1           1. A silica-filled encapsulant composition for  
2     electrical connections, comprising a "core-shell" substance  
3     including a fine powder, whose particles each have an outer  
4     shell with a glass transition temperature above room  
5     temperature, and a core with a glass transition temperature  
6     below room temperature.

1           2. The silica-filled encapsulant composition in  
2     accordance with claim 1, wherein silica fill is in a range  
3     of between approximately 40 and 60 percent by weight of the  
4     total encapsulant composition.

1           3. The silica-filled encapsulant composition in  
2     accordance with claim 1, wherein said encapsulant  
3     composition has a toughness of between approximately 800 and  
4     2,500 psi-in<sup>1/2</sup>.

1           4. The silica-filled encapsulant composition in  
2     accordance with claim 1, including a silane component.

1           5. The silica-filled encapsulant composition in  
2     accordance with claim 1, including at least one from the  
3     group of epoxy resins, polyimides, cyanide esters, and  
4     combinations thereof.

1           6. The silica-filled encapsulant composition in  
2 accordance with claim 5, wherein said epoxy resin comprises  
3 a cycloaliphatic epoxy resin and/or a glycidyl epoxide  
4 resin.

1           7. The silica-filled encapsulant composition in  
2 accordance with claim 5, wherein said epoxy resin comprises  
3 a cycloaliphatic epoxy resin in an approximate weight range  
4 of between 14 and 25 percent by weight of the total  
5 encapsulant composition.

1           8. The silica-filled encapsulant composition in  
2 accordance with claim 2, comprising a cycloaliphatic epoxy  
3 resin in an approximate weight range of between 14 and 25  
4 percent by weight of the total encapsulant composition.

1           9. The silica-filled encapsulant composition in  
2 accordance with claim 2, comprising a cycloaliphatic epoxy  
3 resin and a methyl-hexa-hydrophthalic anhydride both  
4 respectively in an approximate weight range of between 14  
5 and 25 percent by weight of the total encapsulant  
6 composition.

1           10. The silica-filled encapsulant composition in  
2 accordance with claim 9, including a silane component.

1           11. A silica-filled encapsulant composition for  
2           electrical connections, comprising:

1           a) silica fill in a range of approximately  
2           between 40 and 60 percent by weight of the total encapsulant  
3           composition; and

1           b) an epoxy resin and an anhydride both  
2           respectively in an approximate weight range of between 14  
3           and 25 percent by weight of the total encapsulant  
4           composition.

1           12. The silica-filled encapsulant composition in  
2           accordance with claim 11, wherein said composition has a  
3           toughness of between approximately 800 and 2,500 psi-in<sup>1/2</sup>.

1           13. The silica-filled encapsulant composition in  
2           accordance with claim 11, including a silane component.

1           14. The silica-filled encapsulant composition in  
2           accordance with claim 11, wherein said epoxy resin comprises  
3           a cycloaliphatic epoxy resin and/or a glycidyl epoxide  
4           resin.

1           15. The silica-filled encapsulant composition in  
2 accordance with claim 11, wherein said anhydride comprises a  
3 methyl-hexa-hydrophthalic anhydride.

1           16. A silica-filled encapsulant composition for  
2 electrical connections, comprising:

3           a) silica fill in a range of approximately  
4 between 40 and 60 percent by weight of the total encapsulant  
5 composition; and

6           b) a cycloaliphatic epoxy resin and a methyl-  
7 hexa-hydrophthalic anhydride both respectively in an  
8 approximate weight range of between 14 and 25 percent by  
9 weight of the total encapsulant composition.

1           17. The silica-filled encapsulant composition in  
2 accordance with claim 16, wherein said encapsulant  
3 composition has a toughness of approximately between 800 and  
4 2,500 psi-in<sup>1/2</sup>.

1           18. The silica-filled encapsulant composition in  
2 accordance with claim 16, including a silane component.

1           19. The silica-filled encapsulant composition in  
2 accordance with claim 16, including 2-ethyl-4-  
3 methylimidazole as a catalyst.

1           20. The silica-filled encapsulant composition in  
2 accordance with claim 16, further comprising a wetting  
3 agent.

1           21. A method of encapsulating an integrated circuit  
2 chip and a substrate associated therewith, said substrate  
3 comprising organic materials, to form a chip carrier, the  
4 steps comprising:

5                   applying a silica-filled encapsulant composition  
6 to an IC chip and associated substrate, said composition  
7 comprising particles having a core material with a glass  
8 transition temperature,  $T_g$ , below room temperature and a  
9 core-shell material substantially surrounding said core  
10 material, said core-shell material having a  $T_g$  above room  
11 temperature;

12                   curing said encapsulated IC chip and substrate;  
13 and

14                   reflowing solder joints between said IC chip and  
15 said substrate.

1           22. The method of encapsulating an integrated circuit  
2 chip and a substrate associated therewith in accordance with  
3 claim 21, wherein silica fill is in a range of between  
4 approximately 40 and 60 percent by weight of the total  
5 encapsulant composition.

1           23. The method of encapsulating an integrated circuit  
2 chip and a substrate associated therewith in accordance with  
3 claim 21, wherein said encapsulant composition has a  
4 toughness of between approximately 800 and 2,500 psi-in<sup>1/2</sup>.

1           24. The method of encapsulating an integrated circuit  
2 chip and a substrate associated therewith in accordance with  
3 claim 21, including a silane component.

1           25. The method of encapsulating an integrated circuit  
2 chip and a substrate associated therewith in accordance with  
3 claim 21, including at least one from the group of epoxy  
4 resins, polyimides, cyanide esters, and combinations  
5 thereof.

1           26. The method of encapsulating an integrated circuit  
2 chip and a substrate associated therewith in accordance with  
3 claim 25, wherein said epoxy resin comprises a  
4 cycloaliphatic epoxy resin and/or a glycidyl epoxide resin.

1           27. The method of encapsulating an integrated circuit  
2 chip and a substrate associated therewith in accordance with  
3 claim 25, wherein said epoxy resin comprises a  
4 cycloaliphatic epoxy resin in an approximate weight range of  
5 between 14 and 25 percent by weight of the total encapsulant  
6 composition.

1           28. The method of encapsulating an integrated circuit  
2 chip and a substrate associated therewith in accordance with  
3 claim 22, wherein said composition comprises a  
4 cycloaliphatic epoxy resin in an approximate weight range of  
5 between 14 and 25 percent by weight of the total encapsulant  
6 composition.

1           29. The method of encapsulating an integrated circuit  
2 chip and a substrate associated therewith in accordance with  
3 claim 22, comprising a cycloaliphatic epoxy resin and a  
4 methyl-hexa-hydrophthalic anhydride both respectively in an  
5 approximate weight range of between 14 and 25 percent by  
6 weight of the total encapsulant composition.

1           30. The method of encapsulating an integrated circuit  
2 chip and a substrate associated therewith in accordance with  
3 claim 29, including a silane component.